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IRRIGATION IN KANSAS.

By F. G. Adams.

The subject of irrigation is not a new one. Nor is it essentially a scientific subject. The oldest nations of history practiced irrigation; and, in the earliest periods, by methods involving no scientific knowledge. A simple ditch made to turn the water of a brook, and carry it to a level above the adjacent land, whereby it can be spread over, to moisten the cultivated soil of the fields, in the season of crop growing, involves all that is essential to irrigation. Yet where irrigation is done on a larger scale, and broad and deep channels are made, hundreds of miles in length, requiring the construction of aqueducts and bridges and tunnels and reservoirs, at vast expense, and after that a just apportionment of whole rivers of water thus to be brought into use, in its application to thousands of acres of land, and among many thousands of people—in all this, much of science must needs be employed. So in the sinking of wells to great depths, to obtain water for irrigation, scientific investigation is requisite to determine the position of strata, and the reasonable sources of the water supply which is sought. The climatic effects which may accompany the change of the soil, in a district where rainfall is slight, from a state of sterility to one of great productiveness, may be a subject of no little scientific interest.

Is irrigation practicable in Kansas? This is a question which it would seem the facts of science might have long ago helped to solve. If the question has already been solved without such aid, doubtless science may be made to help in carrying forward the work which has been begun without its intervention.

Mr. Gannett's tables of elevations, together with the tables of distances on the Atchison, Topeka & Santa Fe Railroad, show the fall in the waters of the Arkansas river, between Hutchinson and the Kansas State line, to be about eight feet to the mile.

The application of the engineer's level through fifteen miles in Sequoyah county, the third county from the western line of the State, on the Arkansas river, shows the fall in the river there to be about seven and a half feet to the mile. At low stages the river banks are about four feet above the water in the channel; and the bottom lands spread out for miles from the river, at a little more than the same elevation. As the water falls, in the course of the river eastward, so does the adjacent bottom land, seven or eight feet to the mile, through several counties here, perhaps the entire distance from Hutchinson to the west line of the State, and beyond; the uplands, too, have about the same general declivity to the eastward.

In the Arkansas river, four miles above Garden City, in Sequoyah county, and about seventy-five miles from the western line of the State of Kansas, is an island, a mile or more in length, and it comes so near the northern bank of the river that at a point three-fourths of a mile below the upper

end of the island the channel between the island and the main land is but about twenty feet wide. At this point, last February or March, some gentlemen, among whom were Messrs. Landis & Hollinger, of Sterling, and Mr. W. H. Armentrout, of Garden City, under the name of "The Garden City Irrigating Company," threw across this channel a dam of brush-wood and earth. By this means they raised the water in this channel above the dam to the height of nearly five feet, or almost up to the top of the river bank. Here they commenced to dig a ditch eight feet wide and two feet deep. They made the ditch to gradually recede from the river, as they extended it out across the bottom land, so as to run, at the farthest, a mile or two from the river. The ditch is ten miles long.

It was late in June, almost July, before the ditch was so far completed as that water could be used in the irrigation of fields adjacent to it; but, as late as it was, sufficient advantage was derived to crops to bring good results, and the promise of the successful irrigation of large tracts of land in the Arkansas valley, and even on the uplands. In the experiments tried, nothing like fair tests were made, except in a few instances, and that principally in garden patches.

The persons engaged in this experiment did not go about their work with a view of making, in this year's trial, accurate proofs of results; hence no exact evidence appears to be obtainable as to how much of any crop was grown to the acre. Onions and turnips of very large size were still (last week) standing in patches, from which many of the larger, or of earlier growth, had been gathered and sold. Out on the "Great American Desert," turnips sell at \$1.25 per bushel, and the temptation to gather and sell, as they became large enough, was of course irresistible. Potatoes of the finest quality and size were being dug, in fields where the stand is very scattering, from the fact that the seed had dried up and the germ perished before the ground received the water so that they could germinate. There are fields of very scattering corn, of good growth and fair-sized ears, which was planted on sod, late in June. There is abundant testimony to the fact that a patch of sweet potatoes, the plants for which were raised in the open ground, with no hot-bed of any sort, and which were set out in July, yielded nearly a thousand bushels to the acre. The statement is, that there was a little more than an acre of ground, and but little less than a thousand bushels of potatoes. There was no real measurement of the ground on which this extraordinary crop was grown, and no account was kept of the number of bushels dug and sold. They sold at \$2.50 per bushel, and the money was the main object. The owner of this crop, and of most of the crops irrigated, was away in New Mexico most of the summer, looking after gold mines. He was the only man in the settlement who knew anything by experiment of the modes of the application of water in irrigation; and on his farm, the irrigation was done in quite a hap-hazard manner. In no respect has any pains been taken, by the persons engaged in the enterprise, to prove how much irrigation would produce. But the main point has been established—that is, that water, in sufficient quantities for irrigation, and at moderate cost, can be taken from the Arkansas river by ditches, and carried to fields in the bottom lands, in the valley of that river.

The mode of using the water on the farm of Mr. Worrel, was what is called bed-work irrigation. The land is gently-sloping bottom land. It is

laid off in large beds, running in the direction of the slope. The beds are separated by shallow ditches. Skirting the upper end of the entire plat, embracing all the beds, is a main ditch. If it is desired to flood the upper part of any bed, and not the whole of it at once, a furrow is run across the lower end of the portion to be flooded, making a ridge to check the water. Then the water is let from the main ditch of the plat, at the upper end, and the whole of this portion is allowed to become covered with water. Then the water may be allowed to escape into the side ditches, or the supply being cut off, to soak into the ground; or it may be let into another section of the bed, to be in its turn irrigated. On such nearly level land the process is extremely simple, and the work is easily performed.

In the digging of this ditch no engineering was done. The ditch was started a short distance, and water let run in, to see if it would run. Then another portion was dug and tried. Of course a mistake could hardly be made in judging where to run the ditch; having only the main object, and not the best selection, in view. The uniform declivity of the Arkansas river bottom renders it extremely easy to obtain a fall after the water is once brought out upon the bottom land. There are believed to be about six thousand acres of land that can be reached by water from this ditch. An interesting question is, how much land has the ditch actual capacity to irrigate? If the owners proceed upon the plan employed in locating the ditch, that of trial and experience merely, they may meet with disappointment and loss; but doubtless they will in this matter consult the experience of irrigation elsewhere.

Taking the rules of hydraulic engineering as a guide for calculation, and supposing this ditch to have a fall of three feet per mile and a twelve-foot volume of water, its capacity is 153,420 cubic feet of water per hour.

From a lengthy paper on irrigation, in the United States Agricultural Report for 1860, I have been enabled to obtain information for comparison of the Kansas experiments with works of irrigation in other countries.

In the south of France, in Italy and Algeria, where irrigation has long been very extensively practiced, the season of irrigation is, at the maximum, six months; that is, from the first of May to the end of October. Experience has there evolved at least general rules for the computation of the capacity of irrigating canals of various sizes, and the quantity of water required for irrigation; and many other practical matters, the result of long experience and careful observation, have been determined. As to the required quantity of water, the rule is, one litre of continuous water per second for every hectare: that is, fifty cubic feet of water per hour for one acre of ground, taking the season of irrigation through. The Garden City ditch, then, with a capacity of 153,420 feet per hour, will, by the French rule, irrigate 3,068 acres, or about one-half the area of ground within the reach of the ditch. But this ditch can be easily increased to a size necessary to meet any demand that may be made upon it.

The Garden City experiment has naturally enough excited the interest of the people generally in the section of the upper Arkansas valley, and other canals are already projected. One other has been begun, and will be ready to supply water for irrigation early next spring. This is also by a chartered organization called the "Kansas Irrigating, Water Power and Manufacturing Company." Of this company, Mr. C. J. Jones, of Garden

City, was the originator and is the active manager, as he has also been most active in attracting public attention to this practical development of irrigation in Kansas. The canal of this company commences at the west line of Sequoyah county, twelve miles west of Garden City. Its length is about twenty miles. It is already opened for fifteen miles—that is, it is so far made that water has been run through it for that distance. It is to be twenty-two feet wide, and will run four feet of water in depth. The cost of making it is to be not to exceed \$250 per mile. Not a cut or a fill is required for the entire distance of twenty miles. The ditching is done by machinery—that is, by plowing and grading machines constructed for railroad grading and canal excavation. This canal was carefully located by a civil engineer. It has a fall of three feet to the mile. It runs clear out on the upland. It is by no means a straight canal; it has many curves, in order to keep the proper level, or rather declivity; but this winding and twisting will perhaps prove no drawback as to its utility when in use. In commencing it, advantage was taken of a time when the ground had been softened by rain for some inches, and a grading plow was run the whole distance on both sides of the contemplated ditch, making two shallow ditches, some six feet wide, leaving a strip within yet untouched. Water has been let into these shallow ditches, testing the correctness of the engineering, and removing all possibility of difficult excavation in the completion of the canal, by reason of dry and hard ground. The earth yet to be excavated can now, at any time, be softened up by sending a flow of water from the river through the shallow preliminary ditches. As remarked by Mr. Jones, “the company has got the heels of this ditch.” As may well be supposed, the ground in that region is a little dry and hard at times, especially on the uplands.

The area estimated to be in reach of this canal is 38,000 acres. Applying the French rule before mentioned, its actual capacity for irrigation is about 21,600 acres. It can be easily enlarged at any time.

It is one of the most favorable circumstances connected with this irrigation undertaking in the Arkansas valley, that the cost of construction of the canal is remarkably light, compared with what must be the cost in Colorado, New Mexico, and other mountainous districts. The Garden City canal probably cost considerably more than \$100 per mile. But it was made without machinery; and a number of depressions were crossed, requiring considerable filling, which would not have been necessary had its course been laid with skill. As has been said, the canal of the “Kansas Irrigating, Water Power and Manufacturing Company” is being made at a cost of \$250 per mile; and this is twenty-two feet wide and four feet deep, while that of the Garden City Company is but eight feet wide and two feet deep.

The Calusa canal, in Piedmont, Italy, is twenty miles long, as is to be the Kansas canal, and the capacity is about the same, the Calusa canal being eighteen feet broad at the bottom, twenty-six feet at the surface of the water, and having a depth of three and a half feet. Its capacity is the irrigation of 18,000 acres. That of the Kansas canal is to be 21,600 acres. The Calusa canal cost \$8,500 per mile. In this statement of its cost, however, there appears to be included that of fifty-nine bridges, twenty-six aqueducts and two tunnels. In the cost of the Kansas canal—\$250 per mile—no

account is taken of any such accessories. The future may develop the necessity of bringing some of these things into the estimates.

In the Arkansas valley, too, the labor of irrigation, of attending the fields and conducting the water upon crops, must be far less than in hilly districts. Owing to the flatness of the land, large areas can be much more quickly and completely flooded than where the land is more sloping.

The area of land irrigated, or rather partially irrigated, in Sequoyah county the present year, did not exceed 100 acres. There are several thousand acres now plowed and ready for irrigation within the reach of the ditches, which will afford water early next spring; the price of water fixed by the irrigation companies is one dollar per acre for the year, the water to be brought by the ditch-owners to the farms of those to be furnished with it.

The spring rise in the Arkansas begins from the first to the middle of May. The river keeps up high until September or October. It is lowest through the winter and early in the spring. It is the observation of those who have become interested in these irrigation experiments, that there is seldom less than five hundred cubic feet of water in the channel and within reach of the irrigation canals in the upper counties in the Arkansas valley in Kansas. Last April, at Garden City, for four or five days, there was less than that volume, owing to a strong south wind prevailing for that time. But through the season of irrigation a much larger volume of water flows through that portion of the river.

At some distance below Sequoyah county the water sometimes disappears, and is not seen at all above the sandy bed of the river. This occurred last spring, as far up as at a point thirty miles below Garden City. But last spring being a time of general drouth in Colorado and New Mexico, the Arkansas river was unusually low. Yet it may well be supposed that no very correct observations or calculations have been made as to the amount of water the Arkansas river will afford for irrigation. The great breadth of channel and usually shallow current will render correct estimates of the quantity of water flowing within a given time quite difficult.

That there is a large area of land, in these upper counties, within comparatively easy reach of the water of the Arkansas river, there is now no question. Mr. Jones, whose opinion is worthy of great credit, estimates the area in Sequoyah county alone to be 256,000 acres. This area under irrigation and cultivation would afford sustenance to a very large population; especially taking into account the facilities for manufacturing, which will at the same time be afforded.

Should there be any question as to the fertility of the soil to be irrigated in the Arkansas valley, that is at once set at rest by the fact that the waters with which the fields are to be flooded contain the highest elements of fertility. They are charged with the washings of a thousand hill and mountain-sides, and are thick with vegetable sediment; from that which, settled upon the land, makes a slimy paste, to the decaying and crumbling twig of the mountain pine, as large as the little finger. Such deposits are now strewn over a hundred acres of land in Sequoyah county. No one can make an examination of the irrigation begun there without bringing some of it away on his boots.

Alluding again to irrigation in other countries, in the hilly region of Piedmont not less than 2,500 cubic feet of water per second are rendered

available for irrigation, and the extent watered is 180,000 acres. The whole irrigated region of Piedmont is 1,500,000 acres; the amount of cultivated land is 890,454 acres; the total of actually irrigated land is 306,613 acres.

The total quantity of water utilized in Piedmont is 8,290 cubic feet per second, and the area is covered by a network of canals more than 1,200 miles long. The Cavo Morocca canal, in Lombardy, is 150 miles long, and its cost was \$8,000 per mile. The total superficial irrigated region here is 2,500 square miles, or 1,750,000 acres. The slopes range from about 5 to 12 feet a mile. More than 27,000 cubic feet of water are discharged per second. The irrigating season commences in March and terminates in September. The months when the water is in the greatest demand are May, June, July, and August. The average annual fall of rain is given as 37 inches, of which 28 inches fall during the seven irrigating months.

The sum of the statement of irrigation for Lombardy, is a total area of 6,500,000 acres in the irrigated district, of which there are irrigated in summer, 1,061,292 acres; in winter, 12,837 acres; in all, 1,074,129 acres; or about one-sixth of the whole, or one-fifth of the productive area. The great Government canals in Lombardy are 133 miles long. Besides the main lines there are 353 branches, and probably a network of 3,550 miles. East of the Addy they reach 700 or 800 miles, thus making the entire length of the canals of Lombardy 4,500 miles. The discharge of water amounts to 15,118 cubic feet per second, while the whole amount of the discharge of rivers, etc., is 30,000 feet per second. In the entire valley of the Po, Piedmont and Lombardy, there is an extent of irrigation of 1,600,000 acres, or nearly 24,000 cubic feet per second. This view of the canals of Piedmont and Lombardy will serve to show to what a wide extent irrigation is carried on in Italy.

Irrigation is nowhere conducted on so grand a scale as in British India. Some of the canals are like mighty rivers, and a vast extent of country receives the benefit of their waters for agricultural purposes. The first canal dates back to the fourteenth century. The principal canals in India are those of the river Jumna west, of the Eastern Jumna, of the Sutlej, and of the Ganges. The whole length of the main lines of the Western Jumna canal is 445 miles. The total area of the country traversed is 3,784,385 acres. Of this, the irrigated portion is 859,902 acres. The Eastern Jumna has a system of distribution canals measuring 500 miles. The area of the land so watered is 160,000 acres.

Irrigation is extensively carried on in many countries. It is carried on in countries where the need of it and the facilities for it are less than is now apparent in western Kansas. It has been the chief purpose of this paper to call attention to experiments in irrigation in Kansas—experiments which give a promise of good results towards a permanent settlement and cultivation of considerable portions of that part of Kansas over which a doubt, to say the least, has hitherto hung. It seems that it would be worthy the employment by the State of engineering science to determine how far there is, in the Arkansas river and its branches, and in the Smoky Hill and Republican and their branches, a water supply which can be employed in irrigation, and how far such water can be turned into reservoirs upon uplands, to be utilized in manufacturing as well as irrigation. It does not seem improbable

that such work done would pay back to the State many-fold its cost. A scientific survey has long been needed for Kansas, and here is another reason why it should not be delayed.

KANSAS WEATHER SERVICE.

By Prof. J. T. Lovewell, Washburn College, Topeka.

Meteorology has been raised to the dignity of a science by virtue of combined systems of observation over vast areas, corresponding in some degree with the magnitude of the phenomena they undertake to interpret. It has come to be recognized that the problems of meteorology are vast enough to tax the energies and resources of nations; hence, in modern times the foremost governments of the earth have established weather bureaus, and provided a regular system for collecting the facts and arranging them in such a form that scientific deductions and discussions become possible.

Owing to geographical and topographical conditions, as well as to the enterprise of our meteorologists, it has been reserved for the United States to develop the most complete and accurate system of weather observation the world has yet seen. The system, however, is in its infancy, and splendid as have been the achievements of Reed, Maury, Meyer and others, much yet remains to be done to bring it to full development.

There are always to be found in every community willing observers of the weather. It is a subject which concerns everybody; it is the grand piece de resistance on which we fall back when other topics of conversation fail. It affords endless opportunities for guessing and infinite variety in treatment. It is by no means certain that scientific knowledge will in any wise improve the weather as a social theme, for by the methods of science we have nothing to conjecture which can be ascertained by actual observation, and the wise man will remain discreetly silent where knowledge fails. We can, however, afford to sacrifice the poetry of weather and its myths for the sake of truth, and there is a way of utilizing the universal interest in the subject so as to obtain a multitude of willing observers of weather phenomena, each of whom will help in establishing the basis of fact out of which all valuable theories grow and on which they rest.

This organization of volunteer work has been most successfully shown to be possible, by the labors of Hinrichs in Iowa and Nipher in Missouri, while the New York Herald Weather Department has shown what a great metropolitan newspaper can accomplish.

Here in Kansas, we have quite a number of points where meteorological notes have been accurately and systematically kept for quite a number of years. Foremost among these are Professor Snow's valuable observations at the State University, and the Signal Service observations at Leavenworth and Fort Dodge. There are many other points in the State where observa-